Technical Memorandum 5A
Upland Disposal Alternatives

Draft
September 2004

Only sections or other elements of Technical Memorandum 5A revised for the Final EIS are included here. These changed sections combined with the unchanged sections of Technical Memorandum 5A in the Draft EIS constitute Technical Memorandum 5A of the Final EIS. Please see the introduction to the "Changes Made in the Draft EIS in Response to Comments" section for a full explanation.

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1.0 Introduction

One of the disposal options being evaluated for the proposed Carnation Wastewater Treatment Facility is to apply highly treated water (treated wastewater effluent) to an upland area to provide a beneficial use of groundwater recharge. The feasibility of this disposal alternative was addressed in Technical Memorandum 5 (TM5) prepared by the author in 2003. TM5, using existing data, identified an area south of the City of Carnation (City) for which this alternative appeared feasible from a hydrogeologic prospective. A screening procedure was used by Carollo Engineers to specifically identify five parcels for further investigation as potential upland disposal sites. The five parcels have been identified as Sites 20, 21, 125, 126 and 158.

This memorandum presents additional hydrogeologic investigations targeting these five parcels. Specifically addressed are the hydrogeologic setting of the properties and potential impacts that may occur if the properties were to be used for upland disposal.

2.4 Other Analysis

In addition to the above tests and analyses, several methods were used to estimate the population density and well locations near the parcels in question. Aerial photographs taken of the area in August 2001 were obtained from the Washington State Department of Transportation. These were used to locate structures believed to be houses within approximately 2,000 feet of the proposed application sites. Well log records from the Washington Department of Ecology were also obtained for the area. These logs were correlated with GIS information and the aerial photographs to estimate well locations. Analyses of the logs also provide additional subsurface information.

In total, 18 well logs were downloaded from the Ecology database. Nine of these wells were determined to be within approximately 2,000 feet of the proposed application sites. None of the wells are located in the proposed application areas; however, four are sufficiently close that they can be used to further characterize the soils and geology in the proposed application sites. Based upon the owner names given on the well logs, these four wells are identified as the DeBoer well, located less than 1,000 feet northwest of Site 21; the Camp Don Bosco well, believed to be located less than 1,000 feet southwest of Site 21; the Connell well, and the Portwood well, both believed to be located less than 1,000 east of Site 126 and 1,000 feet north of Site 158. All four of logs for these wells indicate sediments that are similar to those found by the borehole drilling at the City's landfill site.

3.2 Soils and Surface Geology

The King County soil survey indicates that the soils covering the six areas being considered for infiltration are entirely covered with Everett Soils (as discussed above). The City's landfill property and three of the four well log sites discussed above also have this soil type. Field work on the City's property confirmed the soil type; presumably the soil type is also correct for the six areas being considered. The soil type has not been confirmed at the well log sites.

The King County soil survey does not indicate a break in soil type between the landfill property and the upland discharge study area. This suggests that the soils are consistent throughout the study area and likely are the same as those found at the landfill site.

The infiltration rate for Everett soils is listed in the soil survey as 2 – 6.3 inches/hr for the top 17 inches, 63 -20 inches/hr for depths of 17 to 32 inches, and greater than 20 inches/hr below 32 inches. While no infiltration measurements were made on Everett soils in the field, observations of the nature of the soil on the City's property tend to support these high infiltration rates.

Turney and others (1995) and Liesch and others (1963) both indicate the surficial geology over the six areas to be Vashon recessional outwash, an uncompacted mixture of sand and gravel. Field observations at the City's property confirmed the presence of Vashon recessional outwash at the surface. On the City's property, the Vashon recessional outwash could be classified as a poorly graded gravel with sand or a sandy gravel. Though the infiltration rate of this material was not measured, it is known to be very high.

3.4 Hydrogeology

The field work performed for this study, along with previous work completed at the landfill, has allowed for a good understanding of the hydrogeology of the adjacent City's property. Well log records for other surrounding properties were used to further assess the hydrogeology of the area.

Borings on the City property show that the recessional outwash gravels at the surface are generally five to fifteen feet thick over most of the southeastern portion of the property. (The gravel outwash is absent on the northern portion of the property, presumably removed by prior mining to the site before becoming a landfill.) Beneath the outwash gravel is a discontinuous fine-grained unit. This unit, on a very local scale, perches water above it in the recessional gravel; but over the scale of the entire property, it is discontinuous enough to allow the recessional gravel to be generally dry. Well log records at the four wells discussed above indicate dry gravelly sediments, with clay, at or near (less than 5 feet) the surface, suggesting similar conditions throughout the area.

As expressed in the boreholes at the City property, beneath the fine-grained unit, or the recessional gravel where the fine-grained unit is missing, is a sequence of silty sands that form the uppermost, widespread saturated zone over the property. This silty sand may represent a fine form of the Vashon advance outwash. All the "B" monitor wells on the City's property are completed in this unit. Similarly, the four well logs all show sequences of "clay"[1] and sand beneath the upper gravelly unit. Three of the four logs indicate water within the "clay" and sand sequence, indicating that it is, like at the landfill property, also saturated. This silty sand unit forms a water table aquifer which probably also exists beneath some or all of the six areas being considered for infiltration. Based on the boreholes at the City's property, the water table aquifer is generally found at elevations of 95 to 115 feet MSL.

Beneath the water table aquifer is a clay-rich layer which varies in thickness across the City property from approximately five feet to more than 20 feet. It appears to thicken to the south. This unit forms a confining layer for the water-bearing sediments below it. On the well logs, this confining unit is represented in two of the four well logs by a clay unit beneath the water table aquifer. The third log (Camp Don Bosco) indicates a till unit, which is also clay-rich, while the fourth (Portwood) lists a non-water-bearing clay, sand and gravel unit.

The lower aquifer at the landfill property is, like the water table aquifer, within a silty sand unit. This confined aquifer beneath the City's property was found at an elevation of 70 to 90 feet and ranges in thickness from ten to 20 feet. Three of the four well logs (Camp Don Bosco, Connell, and Portwood) appear to be completed in this lower aquifer, though it appears to be thicker than 20 feet in all three cases.

The DeBoer well appears to be completed in yet a deeper aquifer. Evidence from other well logs in the area also show deeper confining layers and aquifers present. However, for the purposes of this study, deeper units are not critical to the hydrogeologic discussion.

[1] Though the well logs specifically indicate clay, well drillers often mistake silt for clay, and therefore, it is very possible that the wells encountered a sequence of silty sand rather than clay and sand.

The water table aquifer appears to have a fairly low permeability as a result of its silty nature. Slug testing on Wells 6B and 7B, together with laboratory testing, indicate its hydraulic conductivity is between 0.1 and 1 ft/day. Across the City's property the gradient is 0.04 directed to the northwest, with water level elevations near 117 feet MSL in Wells 6B and 7B and elevations near 104 feet MSL in Wells 3B and 5B (near the northwestern portion of the property). For this project, water levels were monitored in MW5B from September 27, 2003 until the end of February 2004. Over that period the water level in the water table aquifer rose approximately four feet in response to precipitation. While the exact amount of precipitation that fell on the landfill site is not documented, National Weather Service records indicate that approximately 33.5 inches of precipitation fell at Snoqualmie Falls[2] during the period.

The discharge locations for the water table aquifer have not been positively identified. Undoubtedly, much of the water within the aquifer infiltrates downward to the confined aquifer. The fact downward leakage occurs is demonstrated by the head relationships of the two aquifers (that is the water level in the water table aquifer is higher than in the confined aquifer). Besides downward leakage, the aquifer probably discharges to local streams and wetlands. The Langlois Creek wetlands (east of Site 126) and the wetlands at the southwest corner of Site 21 both exist at elevations that are within the elevation range of the water table aquifer (at least its range at the City's property). Therefore, while the flow direction within the aquifer is northwesterly through the City's property, it is probably westerly to southwesterly through Sites 20 and 21, northerly through Site 125, northerly or easterly through Site 126 and easterly through Site 158A. Not enough data is available to estimate the flow direction through Site 158B.

The deeper, confined aquifer appears to be more permeable than the water table aquifer. Data from pumping tests conducted at MW6A and7A indicated transmissivity values of approximately 500 and 1,100 ft^2/d respectively. These values indicate the hydraulic conductivity of the aquifer ranges from approximately 40 to 130 ft/d. Across the City property, the gradient in the confined aquifer is approximately 0.05, directed toward the northwest. Water levels are highest in the south, at approximately 115 feet and lowest in the northwest at approximately 90 feet MSL. Water-level monitoring in MW5A revealed approximately a three-foot increase in water level from September to February in response to precipitation.

Data is not available to identify the discharge locations for the confined aquifer. It likely leaks to deeper aquifers and is discharged to wells for use as a water supply. The aquifer is sufficiently deep that it probably does not discharge directly to local wetlands and streams. It probably discharges upward through a leakage relationship to floodplain sediments near the Snoqualmie and Tolt Rivers. Flow directions across the six properties that are the subject of this report are probably westerly or northwesterly, but specific information to support this assertion is lacking.

To determine the existing quality of ground water at the City's property, a water sample was collected during the testing of MW7A. This well is up gradient from the landfill, so its water quality should be unaffected by any leachate from the landfill. The sample was analyzed for inorganic constituents by a Washington State certified laboratory. Results indicate the water is

[2] Official precipitation records for the month of November 2003 are not available for the Snoqualmie Falls station. Therefore, the total given here substitutes precipitation at the Landsburg Dam station for November.

of excellent quality with all tested parameters below their regulated maximum contaminate levels (MCLs).[3] Selected results are shown below:

Table 1: Selected Water Quality Results

Parameters	Concentration	MCL	Units
Nitrate	1.0	10	mg/l
Iron	0.19	0.3	mg/l
Manganese	0.01	0.05	mg/l
Chloride	2	250	mg/l
Conductivity	141	700	umhos/cm
Total Dissolved Solids	117	500	mg/l

A sample was not collected from the water table aquifer; however, its quality should be similar to that of the confined aquifer.

[3] The results did indicate high turbidity (8 NTU) and color (15 color units). These high values are a result of MW7A being recently drilled and undeveloped. In a properly developed water supply well, it is highly likely the values for these parameters would be much lower.

5.0 Potential Impacts of the Upland Disposal Alternative

Using data generated by this study, the feasibility and potential impacts of using the upland disposal alternative can be discussed. As stated earlier the hydrogeology of the upland discharge study area has been established through field investigations and other analysis of adjacent properties, therefore, a level of uncertainty exists. Given this level of uncertainty the discussion of impacts that follows is a conservative worst case scenario. One potential significant impact is groundwater mounding beneath a potential infiltration basin. The height of mounding determines whether the alternative is feasible.

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